# DSMC – DSMC Method for Simulation of the Multiple Moving and Deformable Bodies in Rarefied Gas Flow

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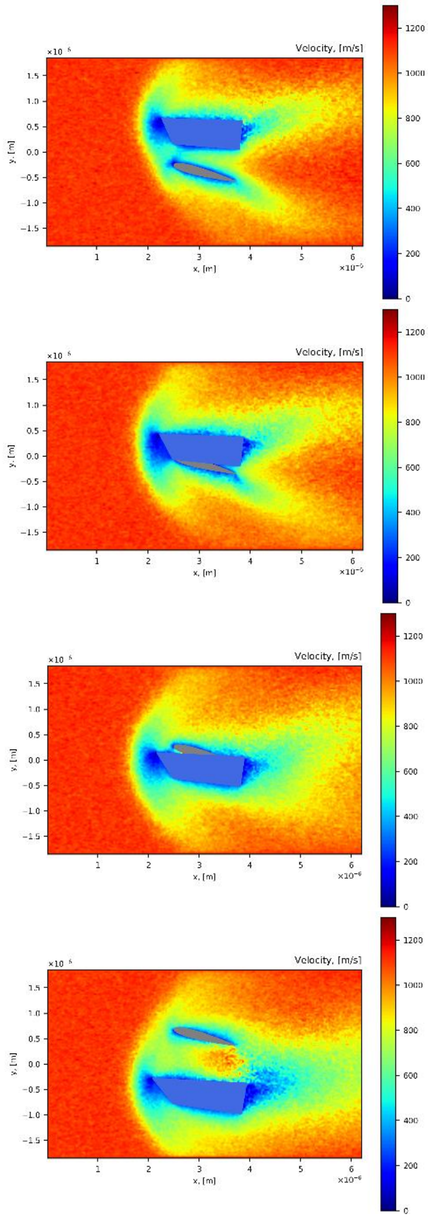


**Figure 1:** DSMC simulation of two moving bodies in a supersonic rarefied gas flow.

## ❖ Description of the problem

To simulate flow past moving deformable bodies, we use Direct Simulation Monte Carlo (DSMC) method [1] to model the rarefied gas flow and Gmsh [2] to generate mesh around the bodies. DSMC is a basic numerical method employed for the study of rarefied gas flows by using a discrete set of a finite number of simulators (particles) modeling the behavior of the molecules of a real gas. Gmsh is an open-source 2D and 3D finite element mesh generator with a built-in CAD engine and post-processor.

The mesh is an important part of the software because it influences performance. Cartesian uniform mesh in the computational domain is used as a basic mesh. In cells of a basic mesh, was used the Transient Adaptive Sub-cells (TAS) technique to improve the DSMC spatial accuracy. An adaptive unstructured mesh is used in a tiny area near the bodies. The mesh around moving and deformable bodies has to adapt continuously. The approach combines fast Cartesian mesh for the larger part of the computational domain and computationally slow unstructured mesh around bodies to represent their geometries correctly.

Figure 1 shows two moving bodies in supersonic rarefied gas flow. The speed of the bulk flow is equal to Mach 3. One of the bodies is the NACA0012 airfoil that is rigid. It is moving upward with a speed of 200[m/s]. The other one is a deformable quadrilateral moving downward with a speed of 200[m/s]. Two bodies overlap when they pass each other. That demonstrates the capabilities of the developed code.

## ❖ Use of HPC Infrastructure

The code is parallel. The parallel organization is based on standard MPI. The results were obtained on a cluster of high-performance servers purchased under the IICT CVP project. DSMC basic Cartesian uniform mesh is 200×120 cells and unstructured mesh around the bodies is around 82000 cells. A total number of particles is $1.7\times10^6$. The airfoil is represented as a polygon of 200 elements.

1. G. Bird, Molecular, Gas Dynamics and the Direct Simulation of Gas Flows, Clarendon Press, Oxford, 1994.
2. http://gmsh.info/